THE ENERGY YARDSTICK:

Using PLACE³S to Create More Sustainable Communities

EXECUTIVE SUMMARY

PRODUCED FOR:

Center of Excellence for Sustainable Development
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

Program Partners:

Oregon Department of Energy	Washington State Energy Office	California Energy Commission

April 1997

PLACE^{3}S PRIMER

☑ PLACE^{3}S is an acronym for **PLA**nning for **C**ommunity **E**nergy, **E**conomic, and **E**nvironmental **S**ustainability.

☑ PLACE^{3}S is a land use and urban design method that uses *energy as a yardstick* to help communities understand how their growth and development decisions can contribute to improved sustainability. PLACE^{3}S clarifies the trade-offs a community must make among its various goals by providing a common yardstick for measuring them.

☑ PLACE^{3}S differs from other methods of community planning by its unique combination of public participation, planning and design, and quantification of the energy, economic, and environmental effects of a plan and its alternatives.

☑ Two computer-assisted planning tools have been developed to help implement the PLACE^{3}S method. INDEX® is proprietary software developed by Criterion, Inc., of Portland, Oregon. Smart Places is public domain software developed by a public-private partnership in collaboration with the Electric Power Research Institute.

☑ The San Diego Association of Governments used PLACE^{3}S to quantify the benefits of their Regional Energy Plan. PLACE^{3}S revealed energy cost savings of nearly $1.5 billion, the creation of over 5,000 new jobs in energy efficiency services, and the elimination of 1/2 million tons of air pollutants over 15 years if the plan was fully implemented.

☑ In the Eugene-Springfield region of Oregon, the Lane Council of Governments used PLACE^{3}S to evaluate the region's existing policies favoring compact growth and transit use. PLACE^{3}S unveiled annual energy cost savings of about $10 million to the region in 2015.

More information about the PLACE^{3}S method of urban planning is available in the full text of the U.S. Department of Energy publication titled *The Energy Yardstick: Using PLACE^{3}S to Create More Sustainable Communities.* This document is available on the U.S. Department of Energy website at http://www.sustainable.doe.gov/pubs/place3s/index.html. It can also be ordered by contacting:

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THE ENERGY YARDSTICK:
USING PLACE^{3}S TO CREATE MORE SUSTAINABLE COMMUNITIES

EXECUTIVE SUMMARY

PLACE^{3}S, an acronym for **PLA**nning for **C**ommunity **E**nergy, **E**conomic and **E**nvironmental **S**ustainability, is a land use and urban design method created specifically to help communities understand how their growth and development decisions can contribute to improved sustainability. The PLACE^{3}S approach to urban planning uses energy as a yardstick to evaluate the efficiency with which we use our land, design our neighborhoods to provide housing and jobs, manage our transportation systems, operate our buildings and public infrastructures, site energy facilities, and use other resources. PLACE^{3}S integrates public participation, planning, design, and quantitative measurement into a five step process appropriate for regional and neighborhood-scale assessments.

> "THE CASE FOR INCLUDING AN ENERGY DIMENSION IN THE URBAN DEVELOPMENT PROCESS IS COMPELLING. NOT ONLY IS ENERGY A CRUCIAL RESOURCE, BUT IT IS ASSOCIATED WITH SERIOUS ENVIRONMENTAL EFFECTS AT ALL SCALES."
>
> SUSAN OWENS, CAMBRIDGE UNIVERSITY

CREATING EFFICIENT COMMUNITIES WITH PLACE^{3}S

Cities can improve their economies, environments, and quality of life by intentionally conserving all forms of energy and promoting reliance on renewable resources in planning and design choices. These widespread benefits are due to the integral nature of energy in communities, where efficiency gains in one sector lead to related improvements in other sectors.

Because of energy's pervasive influence in a community, creating a plan for its efficient use is a good strategy for simultaneously accomplishing other community goals, including:

- ***Affordable housing.*** Lower energy bills for housing and commuting improves eligibility for home financing or renting.
- ***More ways to travel around town and less traffic.*** Energy efficient land uses promote walking, biking, and transit and reduce auto dependence.
- ***Clean air.*** Fewer automobile trips and more efficient houses and businesses reduce air pollutant and greenhouse gas emissions, especially carbon dioxide (CO_2).
- ***Lower cost public services.*** Compact development with a mix of uses reduces the length of water, sewer, natural gas, and electric lines needed to serve a community. Construction, operation, and maintenance costs are less for each taxpayer.
- ***Open space and agricultural land preservation.*** Efficient development of regions and cities reduces urban sprawl.
- ***Increased personal and business income.*** Energy savings translate into more disposable income for individuals and more working capital for businesses. These dollars recirculate in the local economy, creating more economic benefit than dollars used to purchase electricity, natural gas, and gasoline.
- ***Job retention and creation.*** Reduced commercial and industrial energy costs and reinvestment of savings protect existing jobs and offer greater potential for new jobs.

The impact of PLACE^{3}S on community planning can be far reaching and transforming. By adding an energy dimension to existing community planning goals, PLACE^{3}S provides a common yardstick for measuring and comparing trade-offs a community must make. The outcome of the PLACE^{3}S method is a more information-based decision process and more thorough integration of community goals.

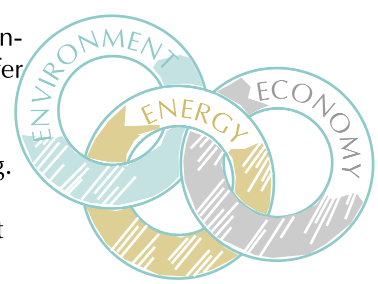
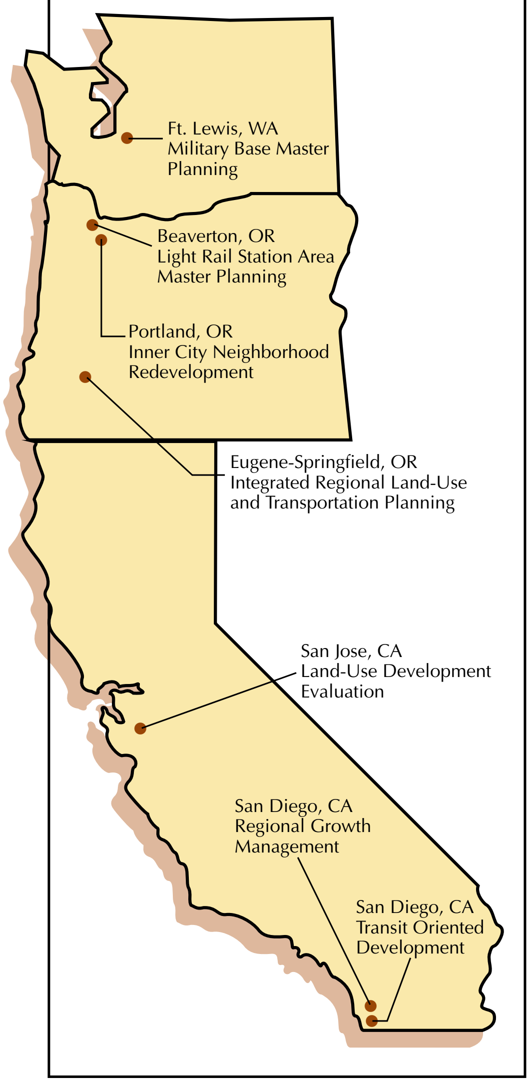


Figure S-1 shows the projects to date that have used PLACE^{3}S to improve the energy efficiency of community plans. These projects range from regional studies that identified efficiency improvements of as much as 12 percent over business-as-usual conditions to neighborhood projects that show gains of as much as 50 percent in dense city centers compared to conventional suburban development.

HOW PLACE^{3}S WORKS

FIGURE S-1

PLACE^{3}S PROJECTS (1994-1997)



In many situations, community planners can integrate the PLACE^{3}S approach into their established planning procedures. They can use PLACE^{3}S to judge the sustainability of their current policies and identify ways to include energy efficiency in their policies. For example, by revealing the per household cost savings and community-wide economic stimulation and air quality benefits, PLACE^{3}S can help determine the extent to which an affordable housing plan contributes to community sustainability. After a community becomes familiar with the data and mapping the PLACE^{3}S approach can provide, decision-makers will begin to look for the energy differences among the policy choices they are making.

The PLACE^{3}S approach can strengthen an established public involvement process by providing better information to all stakeholders as they evaluate alternatives. The PLACE^{3}S approach also can be a stand-alone process whose primary objective is improving energy efficiency and related economic and environmental conditions. A regional energy plan that projects demands for all sectors and recommends options for meeting those demands is an example of this type of application.

Regardless of how a community initially uses it, eventually the PLACE^{3}S approach can become an integral part of the community development process. Just as planning commissions expect to receive traffic impact estimates for new development proposals, over time they should be able to expect comparable estimates of energy efficiency and other indicators of sustainability.

As Figure S-2 shows, the PLACE^{3}S method measures and compares a set of plans that stakeholders create. A standard PLACE^{3}S approach should include the following alternatives:

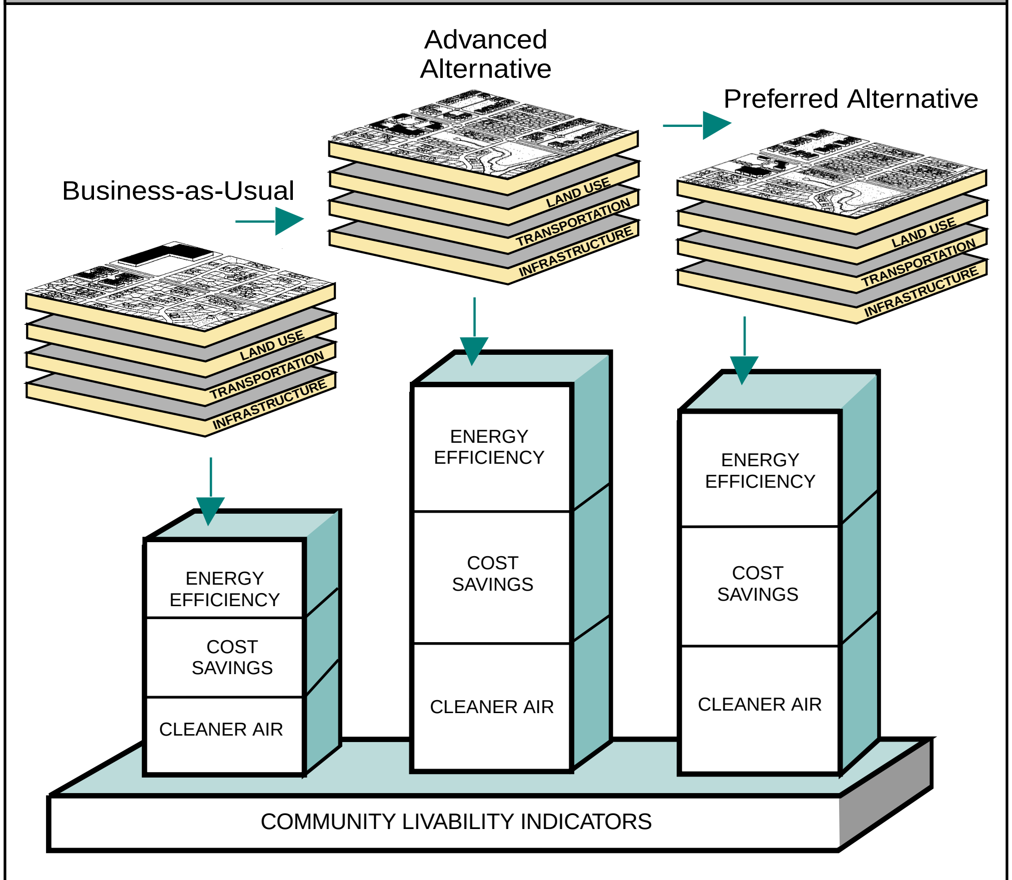
- ***Existing Conditions.*** Existing conditions include a description of the current development and level of efficiency.

- ***Business-as-Usual Alternative.*** This alternative describes future conditions if no policy changes are made (how efficient the community will be at the end of its planning horizon, often 20 years).

- ***Planning Alternatives.*** These alternatives reflect different stakeholder visions for the future. There can be any number of planning alternatives. At least one of these alternatives, referred to throughout this document as the Advanced Alternative, will show how optimizing efficiency can provide economic and environmental benefits.

- ***Preferred Alternative.*** This plan is the outcome of employing the PLACE^{3}S method in a public decision-making process. It represents the stakeholders' balancing of the costs, benefits and impacts of each alternative in a trade-off process. Exposure to and appreciation of the economic and environmental benefits of the Advanced Alternative can lead stakeholders to chose an efficient Preferred Alternative.

FIGURE S-2
THE PLACE^{3}S PLANNING METHOD



"A KEY ROLE FOR PLANNERS IN THE DEVELOPMENT OF INTEGRATED POLICY IS TO MAKE THE COMPLEXITY OF THE INTERACTIONS INTELLIGIBLE TO DECISION MAKERS AND THEIR CONSTITUENTS SO THAT DECISIONS ARE BETTER INFORMED."

TERRY MOORE AND PAUL THORSNES, THE TRANSPORTATION/ LAND USE CONNECTION

There are three main components to the PLACE^{3}S method:
- **Public participation**
- **Planning and design**
- **Measurement**

Public Participation

A primary purpose for using the PLACE^{3}S approach is to inform the public and decision-makers about quantitative differences among alternative development proposals. Because PLACE^{3}S applies a common set of assumptions to all analyses, it compares alternatives fairly, promoting greater public understanding and reducing conflict.

Planning and Design

The second component of the PLACE³S method is the development of a clear set of planning and design principles that describe a community's values related to sustainability. These principles focus the planning process on locally important resource efficiency issues. PLACE³S does not specify the exact principles that lead to optimum efficiency for all communities. Instead, it offers a menu of efficiency options from which a community can construct a custom plan. Figure S-3 summarizes the many ways the PLACE³S method can be used.

> "A REPEATED THEME IN THE LITERATURE ON URBAN ENVIRONMENTAL PROBLEMS IS THE NEED FOR A MORE INTEGRATED APPROACH TO PLANNING."
>
> WILLIAM ANDERSON, URBAN FORM, ENERGY AND THE ENVIRONMENT

Measurement

The third component of the PLACE³S method is measuring the energy impacts of community plans and monitoring energy indicators to see whether the community is becoming more or less sustainable over time. The objective is to give decision-makers quantitative information that strengthens the argument for resource-efficient choices.

The energy sectors that PLACE³S measures include:

- ***Transportation.*** How much gasoline, diesel, and alternative fuels do cars, trucks, and transit vehicles use? Transportation energy is usually the largest end-use sector in a community, often accounting for 40 to 50 percent of total energy use annually.

FIGURE S-3

HOW PLACE³S CAN BE USED

PLACE³S can be valuable to a variety of stakeholders working on many different projects. For example:

- **Citizens** evaluating whether a proposed development will protect the environment and promote efficient resource use.
- **Neighborhood associations** working with their local government to develop a community plan that meets their objectives, including efficiency.
- **Developers and consultants** designing projects to meet local government standards for minimizing automobile travel and promoting density in urban areas.
- **Developers and consultants** quantifying the cost savings per household attributable to good design as a marketing tool for promoting their project.
- **Local government staff and decision-making bodies** evaluating development applications to ensure they meet efficiency and sustainability standards.
- **Councils of governments** preparing regional growth management plans to conserve farm land and open space, support transit and reduce air pollution.
- **Transportation agencies** promoting land-use patterns that encourage transit use, bicycling, walking, and other alternatives to driving alone.
- **Energy utilities** trying to match existing transmission and distribution capacity with community growth to minimize the need for additional substations and related facilities and to promote the use of local energy supply resources.
- **Military bases** facing expansion, redevelopment or reuse.

- ***Residential/Commercial/Industrial.*** How much electricity, natural gas, and other fuels do heating and cooling, lighting, and appliances and equipment in buildings use? PLACE^{3}S also tabulates the energy embodied in the manufacturing and transport of construction materials. The residential sector is normally 20 to 30 percent of total community energy use, with the commercial and industrial sectors often accounting for another 20 to 25 percent.
- ***Infrastructure.*** How much electricity do street lights, traffic signals, and water and sewer systems use? PLACE^{3}S also measures energy embodied in the construction of streets and utility systems. Community infrastructure normally amounts to 5 to 10 percent of total community energy use.
- ***Energy production.*** In contrast to the consumption measurements described above, this category measures energy output for local renewable energy resources such as solar, wind, and geothermal and for high-efficiency technologies such as cogeneration and district heating and cooling. These types of production resources can make communities more self-sufficient and can extend the life and efficiency of existing electric and natural gas distribution grids.

All of these measurements involve a variety of energy types and fuels that are described in unique units. Electricity use, for example, is normally expressed in kilowatt-hours (kWh), while gasoline consumption is measured in gallons. To simplify tabulations, the PLACE^{3}S method directs planners to convert all energy values into a common expression of British thermal units (Btu). Because a single Btu is a small amount, PLACE^{3}S uses one million Btu (MMBtu) as its standard unit of energy measurement. PLACE^{3}S uses quantifications of energy use, energy cost, and energy-related air pollutant and CO_2 emissions to document existing conditions and compare alternatives.

DATA AND COMPUTER NEEDS

PLACE^{3}S can be a data-intensive planning method. In large communities or regions, the method's reliance on energy measurements means that participants must use computers to assemble and interpret large amounts of data, especially when evaluating multiple planning alternatives. In small community or neighborhood settings, however, a modest amount of data and hand calculations may support a PLACE^{3}S study. Either way, the objective of PLACE^{3}S is not elaborate "number crunching" for its own sake, but rather the reasonable use of data to inform decision-makers of the implications of their choices. Local priorities and resources will determine how many data are enough and how to compute them. PLACE^{3}S is flexible enough for users to adapt the methodology to function with their databases.

Many of the data needed for PLACE^{3}S will already be available from other planning processes. Local data bases almost always document the number, size, and location of dwelling units, for example. The PLACE^{3}S method simply takes those existing data and adds another set of coefficients to estimate the energy needs of dwelling units and their emissions. PLACE^{3}S estimates energy used by businesses, transportation and infrastructure, which local data bases also normally document, in a similar manner. Figure S-4 lists sources of basic energy data that can be modified or expanded upon at the local level with the help of energy utilities, government agencies, universities, and consultants. Figure S-5 illustrates a partial coefficient matrix.

Figure S-6 summarizes the major types of information needed for the PLACE^{3}S approach as layers in a geographic information system (GIS) to emphasize the relationship between urban geography and energy efficiency. Use of a GIS for PLACE^{3}S focused planning makes the process more efficient and strengthens its ability to commu-

"A community that does not scrutinize every significant proposal for new growth is gambling its future as surely as would a trip to Las Vegas with the municipal treasury. We can no longer heedlessly assume that any expansion will strengthen the community's economy."

Michael Kinsely & Hunter Lovins, *Paying for Growth, Prospering from Development*

FIGURE S-4

ENERGY DATA SOURCES

Annual Energy Outlook with Projections Existing conditions and 20 year forecasts of energy supplies and demands by fuel type and end-use.

Household Energy Consumption and Expenditures. Survey of consumption and expenditure patterns for all residential energy use, except household transportation.

Household Vehicles Energy Consumption. This is a companion residential survey devoted to household transportation, including vehicle types, miles traveled, and fuel efficiency.

Commercial Buildings Energy Consumption and Expenditures. Survey of commercial building energy consumption by building type, energy end-use, and fuel type nationally.

National Personal Transportation Survey. Comprehensive survey of all forms of personal travel, including non-motorized and transit modes.

Transportation Energy Data Book. Detailed national breakdown of energy consumption, costs, and air pollutant emissions for all motorized travel modes.

These are national databases with breakdowns by multi-state regions. The USDOE periodically updates and distributes them, except the National Personal Transportation Survey, which the USDOT issues, and the Transportation Energy Data Book, available from the US Department of Commerce.

nicate results to the public and decision-makers. Use of a GIS can also be coordinated with the computer-aided design (CAD) work of land developers and engineers, who are often preparing the growth proposals that PLACE^{3}S can evaluate. In fact, one way of promoting stakeholder collaboration in a PLACE^{3}S project is to establish the joint use of common computer data files and equipment.

In projects in which computer help is appropriate, hardware and software requirements are not extensive. If a community or region already operates a GIS, it already possesses a system it can adapt to make PLACE^{3}S calculations. In locations without a GIS, a personal computer and spreadsheet software can tabulate data, which are then transferred to drawings. A CAD system can also automate this approach.

Criterion, Inc. of Portland, Oregon has developed proprietary software to assist communities in applying the PLACE^{3}S method. The current version of this software, called INDEX® requires Arc View™ from ESRI Inc. and a 486 PC (or MAC) with 16 MB of RAM. Operation may require up to 100 MB of hard drive space depending on the study size. INDEX is not plug and play software. It may need to be customized to answer unique questions. Also, data describing the study area must be entered into the program before operation. Contact Eliot Allen, Principal, Criterion, Inc., for details about INDEX. [eliot@crit.com or (503) 224-8606].

Software to help implement the PLACE^{3}S method has also been developed as part of the redesign of Denver's Stapelton Airport property. This software, called Smart Places,

FIGURE S-5

SAMPLE COEFFICIENT DEVELOPMENT

SINGLE-FAMILY RESIDENCE	Electric lights & appliances	+	Natural gas space & water heating	=	Annual Single-Family Housing Coefficients
Energy use/yr	13,804 kWh (or 47 MMBtu)	+	590 therms (or 59 MMBtu)	=	106 MMBtu
Energy cost/yr	7¢/kWh (or $944)	+	57¢/therm (or $335)	=	$1,219
Pollutant emissions/yr	0.13 lbs/CO/MMBtu (or 6 lbs.)	+	0.02 lbs./CO/MMBtu (or 1 lb.)	=	7 lbs. CO
Greenhouse gas emissions/yr	412 lbs./CO_2/MMBtu (or 19,427 lbs.)	+	116 lbs./CO_2/MMBtu (or 6,774 lbs.)	=	26,201 lbs. CO_2

AUTOMOBILE	→	Gasoline	=	Annual Auto Travel Coefficients
Energy use/Yr		650 gallons (or 81 MMBtu)	=	81 MMBtu
Energy cost/yr		$1.13/gallon (or $737)	=	$737
Pollutant emissions/yr		2.2 lbs./CO/MMBtu (or 180 lbs.)	=	180 lbs. CO
Greenhouse gas emissions/yr		155.4 lbs./CO_2/MMBtu (or 12,956 lbs.)	=	12,956 lbs. CO_2

is a decision support system for sustainable land use and development. Like INDEX®, it is built to function with ESRI's Arc View™ geographic information system software. The Smart Places system software is designed to be flexible, allowing modifications to fit community project needs. Smart Places is public domain software developed by a public-private partnership in collaboration with the Electric Power Research Institute. For more information about Smart Places contact Paul Radcliffe at EPRI (pradclif@epri.com).

PLACE^{3}S: STEP BY STEP

There are five basic steps to applying the PLACE^{3}S method. The five steps are general enough to fit most local circumstances, but adjustments and fine tuning will likely occur when applying them. The steps are:

Step 1: Start-up
Establish the geographic scope of the PLACE^{3}S project, along with its relationship to other planning projects affecting the study area. Begin stakeholder participation, including formulating criteria for evaluating planning alternatives. Collect data and document existing conditions.

FIGURE S-6

INFORMATION NEEDED FOR PLACE^{3}S STUDY

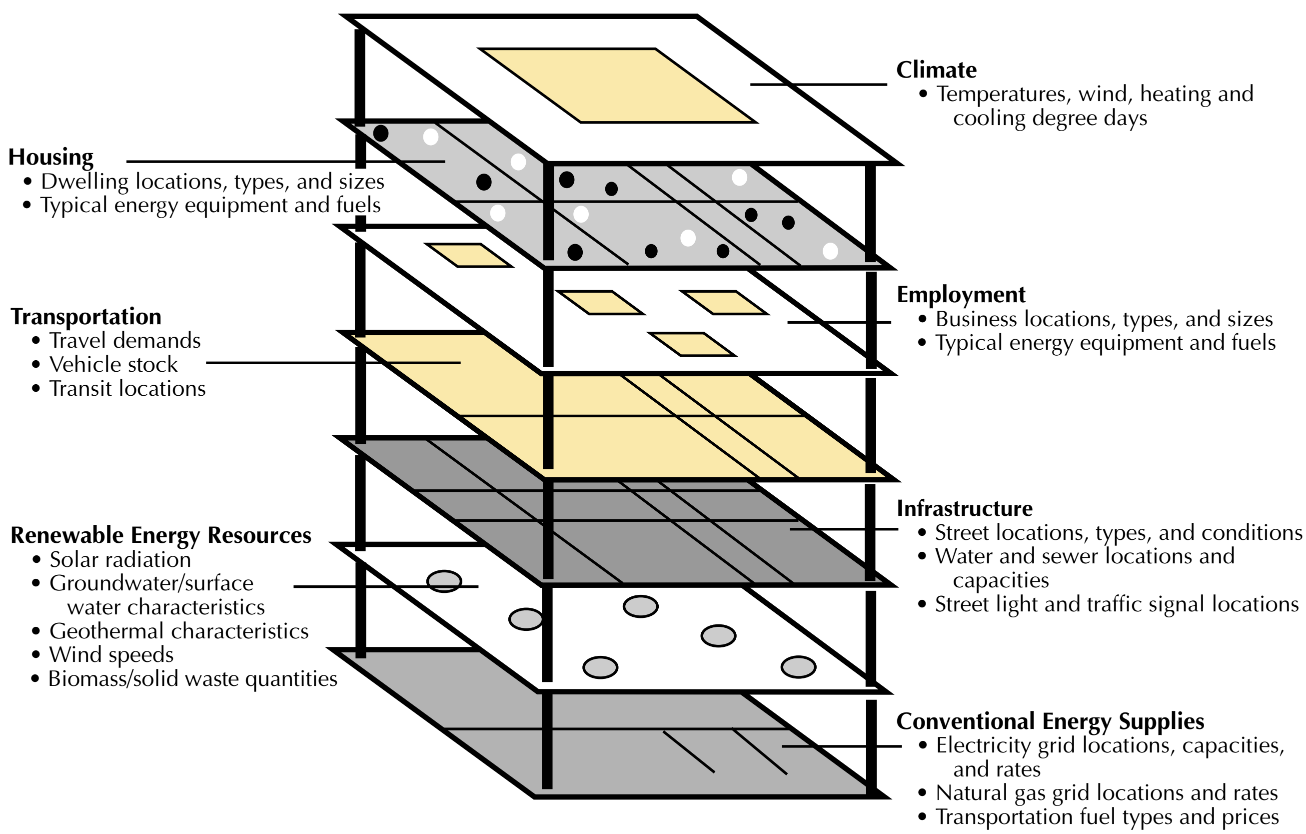


FIGURE S-7

MENU OF PLACE^{3}S EFFICIENCY MEASURES

Landform/Microclimate
- Topography
- Light-colored surfacing
- Vegetative cooling
- Wind buffering/ channeling
- Evaporative cooling

Land-Use/Site Design
- Use density
- Use mix
- Activity concentration
- Solar orientation
- Pedestrian orientation
- Transit orientation
- Microclimatic building siting

Transportation
- Integrated, multimodal street network
  - Pedestrian
  - Bicycle
  - Transit
  - High-occupancy vehicles
- Pavement minimization
- Parking minimization/ siting

Infrastructure Efficiency
- Water supply and use
- Wastewater collection
- Storm drainage
- Street lighting
- Traffic signalization
- Recycling facilities

On-Site Energy Resources
- Geothermal/ groundwater
- Surface water
- Wind
- Solar thermal/ Photovoltaic
- Biomass
- District heating/cooling
- Cogeneration
- Thermal storage
- Fuel cell power

Step 2: Establish Business-as-Usual Alternative
Project existing conditions or an adopted plan to the end of the planning horizon to create the Business-as-Usual Alternative. The objective is to simulate current policies and market trends if they continue without change. Measure the energy efficiency of the Business-as-Usual Alternative to set a baseline for comparing alternatives.

Step 3: Analyze Alternatives
Develop and evaluate alternatives that improve upon the Business-as-Usual plan. These alternatives will address major planning issues such as redirecting growth and new transportation programs. One alternative, the Advanced Alternative, should focus on optimizing efficiency. Figure S-7 provides the design menu for constructing the Advanced Alternative. Compare energy use, costs and air pollutant and CO_2 emissions of each alternative against the other alternatives to determine how much more or less efficient the community could become under each alternative.

Step 4: Create Preferred Alternative
Create the Preferred Alternative by selecting the strongest alternative or constructing a hybrid composed of elements from the multiple alternatives assessed in Step 3. Use the public process to construct the Preferred Alternative to achieve the best balance of energy efficiency and other community values. Document the expected level of energy efficiency, cost savings, and air quality and CO_2 emission improvements for use in Step 5.

Step 5: Adopt, Implement, Monitor, and Revise
Adopt the Preferred Alternative and use its energy, costs, and air pollutant and CO_2 emission levels for measuring success in achieving its goals. Evaluate intervening short-range development proposals and plans against these goals to ensure that incremental efficiency improvements are occurring.

Implementation should include monitoring and evaluation of expected energy efficiencies. Agree on benchmarks and periodically collect data to compare them against predictions. Make amendments as needed to ensure that efficiency goals are realistic and are being met.

A Simple Example

Figure S-8 shows a simple application of the PLACE^{3}S method. This example is a fictional 100-acre "greenfield" parcel being developed around a new light rail station. Three alternative scenarios vary the density and land-use mix to produce considerably different results. Each plan has different implications for community sustainability.

CREATING EFFICIENT REGIONS

For the last half of the 20th century, the dominant pattern of metropolitan growth in the U.S. has been unlimited, low-density sprawl. This pattern of urban growth creates auto-dependent suburbs surrounding weakened central cities and threatens the long-term sustainability of metropolitan regions. Traffic congestion, air pollution, lack of affordable housing, loss of open space, and expensive new infrastructure are just a few of the results of sprawl that many metropolitan regions share.

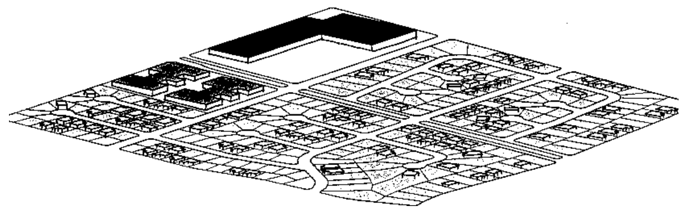
Most metropolitan areas now have agencies that address these regional issues. Planning at the regional level includes growth management, transportation, air quality, open space, and economic development. In general, these plans strive to make re-

FIGURE S-8

A SIMPLE PLACE^{3}S APPLICATION

1. BUSINESS-AS-USUAL: Developer proposes to build on a 100-acre parcel at four units to the acre. The PLACE^{3}S profile reveals the following:

- Total development requirement: 100 acres
- Open space reserved: 0 acres
- Homeseekers served: 348
- Transit feasibility: Poor, too few residents within walking distance of transit- good transit service not economically viable.
- Local Street Connectivity: Poor, few streets provide direct access to transit.



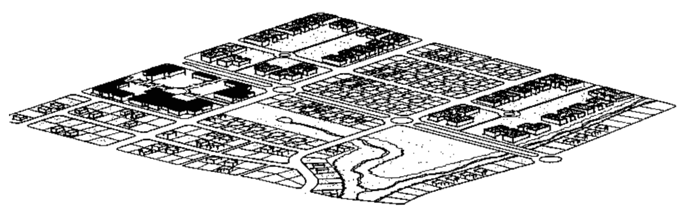
Residential Units
Single-family: 268
Multi-family: 80

Commercial Square Footage
Retail: 65,000
Other: 0

- **175 MMBtu/person/yr**
- **$2100/person/yr**
- **22 tons CO_2/person/yr**

2. ADVANCED ALTERNATIVE: Community develops an alternative that doubles housing to meet projected need and doubles density to conserve resources, lower prices and preserve the environment. The PLACE^{3}S profile reveals the following:

- Total development requirement: 82 acres
- Open space reserved: 18 acres
- Homeseekers served: 770
- Transit feasibility: Excellent, 95% of residents are within walking distance of transit
- Vertical mixed uses in Activity Center
- Local Street Connectivity: Excellent, streets provide direct access to transit, shopping and employment
- Pavement minimization: skinny streets.



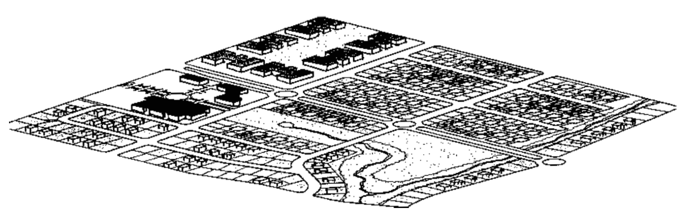
Residential Units
Single-family: 470
Multi-family: 300

Commercial Square Footage
Retail: 35,000
Other: 20,000

- **125 MMBtu/person/yr**
- **$1500/person/yr**
- **16 tons CO_2/person/yr**

3. PREFERRED ALTERNATIVE: After assessing all alternatives in public meetings and negotiating trade-offs, the community removes some multi-family homes and open space, but agrees to a plan that is an improvement over the Business-As-Usual Alternative. The PLACE^{3}S profile reveals the following:

- Total development requirement: 85 acres
- Open space reserved: 15 acres
- Homeseekers served: 452
- Transit feasibility: Good, density partially supports transit
- Horizontal mixed uses in Activity Center
- Local Street Connectivity: Good, most streets provide direct access to transit and shopping



Residential Units
Single-family: 302
Multi-family: 150

Commercial Square Footage
Retail: 45,000
Other: 5,000

- **140 MMBtu/person/yr;**
- **$1900/person/yr**
- **19 tons CO_2/person/yr**

gions more efficient, either directly or indirectly, through more rational use of land and economic and environmental resources.

By using conventional benchmarks of energy efficiency, such as total energy use or per capita use, PLACE^{3}S makes explicit the relative differences in the degree of sustainability among regional alternatives. PLACE^{3}S does this by carefully evaluating the following two basic linkages between energy and regional development (adapted from Owens, 1991):

- **PLACE^{3}S quantifies the energy demands that the arrangement of land-uses throughout the region create.** For example, low-density development creates a need for greater travel between uses than compact development. A mixture of land-uses makes it easier to walk to work and shopping or to take shorter auto trips.
- **PLACE^{3}S matches energy production and distribution systems to the land-uses and transportation systems they will serve.** For example, district heating and cooling is most feasible in high-density, mixed-use areas, in contrast to passive solar use, which is most easily used in lower density areas where buildings can be oriented to best solar exposure. Regional assessments of energy generation and distribution will reveal ways to direct growth to reduce costs and pollution.

> "FROM AN ECOLOGICAL PLANNING PERSPECTIVE, THE AMOUNT OF GROWTH IS LESS IMPORTANT THAN THE PATTERN OF GROWTH IN DETERMINING THE LEVEL OF ENVIRONMENTAL IMPACT AND THE EFFICIENCY OF RESOURCE USE."
>
> MARK ROSELAND, ECOLOGICAL PLANNING FOR SUSTAINABLE COMMUNITIES

The objective of using PLACE^{3}S for regional assessments is to identify the region's efficient locations and to ensure that land-use, transportation and infrastructure plans capture the efficiencies that are inherent in those locations. For example, if an area is close to transit and jobs, it should be zoned for high-density uses.

In summary, a regional application of PLACE^{3}S will:

- Establish quantified benchmarks of how energy-efficient the region is and how efficient it will likely be in the future under various planning alternatives.
- Identify areas where land-use changes can improve efficiencies.
- Estimate and contrast the economic development value of efficiency for current and alternative development conditions.
- Estimate air pollution and CO_2 emissions for each regional planning alternative.

In this way, stakeholders can use PLACE^{3}S to understand better the implications of alternative regional plans and to understand the patterns and levels of efficiency those plans would create.

CREATING EFFICIENT NEIGHBORHOODS

The PLACE^{3}S method can help communities plan and design sustainable neighborhoods by employing urban design principles reminiscent of traditional community land-use patterns. These traditional communities, built before every family owned one or more automobiles, tend to be compact and inherently energy efficient.

Neighborhoods designed using the PLACE^{3}S method will be compact with a mix of housing, shops, offices, schools, parks, and other recreation easily available by walking, bicycling, and using transit, as well as by using a car. People are seeing the benefits of having a mix of housing, stores and services in a neighborhood. These neighborhoods are energy efficient and cost residents less. They have good access to local and regional transportation networks and are connected to community water, sewer, and energy infrastructure. Some use local sources of energy.

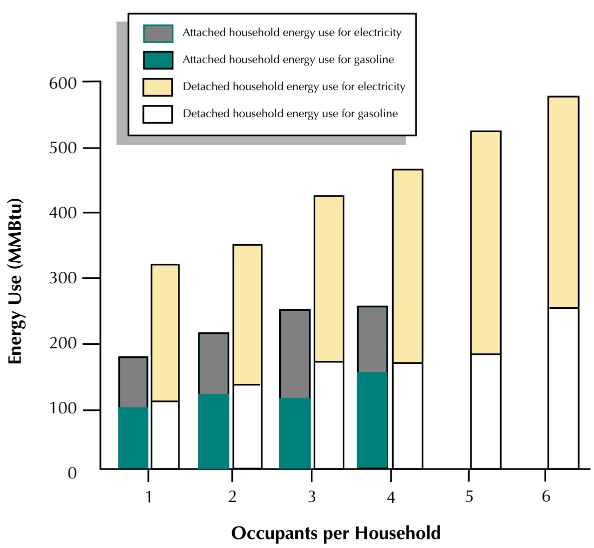
Energy relationships are numerous and complex within neighborhoods. Housing, employment, recreation, travel, infrastructure, and use of local renewable energy resources all affect energy use or supply. Figure S-9 shows a good example of the relationship between neighborhood development and energy use. Taken from a Florida Solar Energy Center survey, it illustrates the lower housing and transportation energy demands of higher-density residential areas.

Applying energy data at the neighborhood level is similar to the regional PLACE³S procedure. In fact, many data from a regional PLACE³S analysis apply to neighborhood studies. For example, energy use, cost, and air pollutant and CO_2 emission coefficients are normally reusable at the neighborhood level. In contrast to regional planning, neighborhood evaluations can also include much more design detail in planning alternatives. Neighborhood energy planning can look for efficiency at the block or building levels. The neighborhood-level PLACE³S design approach is described in Figure S-10. It functions as a framework for selecting and applying efficiency measures from the PLACE³S menu in Figure S-7.

> **"THE DUAL COSTS OF (1) PROVIDING NEW INFRASTRUCTURE FOR THOSE WHO ARE MOVING OUTWARD, AND (2) MAINTAINING THE OLD INFRASTRUCTURE FOR THE POPULATION AND ECONOMIC ENTITIES THAT ARE LEFT BEHIND, CAUSE TAXES AND DEVELOPMENT COSTS TO RISE THROUGHOUT THE METROPOLITAN AREA, THUS CAUSING A REGIONAL RISE IN THE COSTS EITHER TO DO BUSINESS OR TO RESIDE IN THE AREA."**
>
> ROBERT W. BURCHELL & DAVID LISTOKIN, LAND, INFRASTRUCTURE, HOUSING COSTS AND FISCAL IMPACTS ASSOCIATED WITH GROWTH

FIGURE S-9

THE COMPARATIVE NEIGHBORHOOD EFFICIENCIES BY HOUSING TYPE



In 1990, the Florida Solar Energy Center surveyed 10 neighborhoods totaling approximately 300 households to determine relationships between land-use, density, dwelling types, travel behavior, and energy use. Major findings included:

- Detached households consumed 85 to 99% more energy than attached households of equal size.
- Detached households consume more gasoline than attached households of equal occupancy.
- Forty-seven percent of attached households reported that someone walked or biked to a store or park as opposed to just 17% of detached households.
- Detached households consume substantially more electricity than attached households of equal occupancy.
- Distances to work, schools, and most errand trips were shorter for attached households.
- Food store was easily accessible by walking or bicycling according to 42% of attached households as compared to only 4% of detached households.

In summary, PLACE^{3}S neighborhood-level studies will:

- Characterize energy efficiency, cost and air pollutants attributable to multiple development proposals.
- Determine the net energy use, energy cost and energy-related air pollutant and CO_2 emissions difference between a community built according to an adopted plan or an amended plan.
- Help a community integrate planning goals, make difficult trade-offs, and take positive steps toward sustainability.
- Improve coordination between regional and local planning, helping each to better achieve goals and improve sustainability.
- Produce a data base with many long-term uses including monitoring the success of plans and reducing uncertainty for developers participating in the planning process.

> "You are right on track when your solution for one problem... solves several others. You decide to minimize automobile use to conserve fossil fuels, for example, and realize that this will reduce noise, conserve land by minimizing streets and parking, multiply opportunities for social contact, beautify the neighborhood, and make it safer for children."
>
> Michael Corbett, Developer in Davis, CA.

FIGURE S-10

PLACE^{3}S NEIGHBORHOOD DESIGN APPROACH

Minimize Energy Demands

1. Use large-scale land forms and microclimate to identify the most weather-protected development sites, which will reduce building heating and cooling demands.
2. Consider small-scale land forms, landscape, existing buildings and pavement, solar orientation, and other issues that affect microclimate when subdividing parcels and siting buildings to further reduce building energy demands.
3. Increase land-use mixes and densities to reduce travel requirements, to further reduce building heating and cooling demands, and to increase infrastructure operating efficiencies.
4. Orient circulation and parking to pedestrians, bicycles, and transit to reduce auto dependence; and, provide infrastructure for alternative transportation fuels.
5. Minimize infrastructure and optimize its operation to reduce embodied and life-cycle energy needs.

Optimize Energy Supplies

6. Maximize the use of on-site renewable energy resources and high-efficiency technologies to rely less upon imported energy and reduce demands for grid-delivered electricity and natural gas, thereby prolonging the existing energy infrastructure's ability to deliver adequate supplies.
7. Interconnect with electric and natural gas grids at locations with sufficient capacity to avoid or minimize the need for new transmission or distribution lines and equipment.